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Received March 15, 1770.

XXIII. *On the late Transit of Venus: By*
Nathan Pigott, Esq; to Dr. Bevis, F.R.S.

Caen, Lower Normandy, Feb. 9th, 1770.

Dear Sir,

Read April 26, 1770. **I** TAKE the opportunity of Capt. Hue's sailing from this place, to send you the observations of the last transit of Venus over the Sun, made here, and which I would have remitted sooner, if an opportunity had offered. I should be obliged to you, if you would communicate these observations to the Royal Society. I have added those of other observers, which have been sent to me, from different places, and reduced the same to the observatory of Paris, keeping an account only of the difference of meridians, as inserted in the *Connoissance des tems*, and omitting the small correction of the parallax, suitable to the different situation of these places, because, I presume, the longitude of some of them, is not known with sufficient precision, to admit here of this very small equation.

TABLE OF OBSERVATIONS reduced to the Meridian of the R. Observatory, at Paris.

Places of observations	Observers	External contact	Internal contact	Focus of instruments	Mag- powers	External contact reduced to Paris	Internal contact reduced to Paris
	Mess.	h ' "	h ' "			h ' "	h ' "
Greenwich	Makeline	7 10 55	7 29 23	telescope 2 feet	140	7 20 11	7 38 39
	Hitchens	7 10 54	7 28 57	telescope 6 feet	90	7 20 10	7 38 13
	Hirt	7 11 11	7 29 18	telescope 2 feet	55	7 20 27	7 38 34
	Horsley	7 10 44	7 29 28	achro. 10 feet	50	7 20 00	7 38 44
	Dun	7 10 37	7 29 48	achro. $3\frac{1}{2}$ feet	140	7 19 53	7 39 4
Kew	Dollond	7 11 19	7 29 20	achro. $3\frac{1}{2}$ feet	150	7 20 35	7 38 36
	Nairne	7 11 30	7 29 20	telescope 2 feet	120	7 20 46	7 38 36
	Bevis	7 10 2	7 28 17	telescope $3\frac{1}{2}$ feet	120	7 20 27	7 38 42
Caen		7 9 20	7 27 43	telescope 12 inches		7 20 7	7 38 30
Obf. of Paris	Duke of Chaulnes						7 38 11,5
Ditto	Messier						7 38 58
Paris	Baudouin						7 38 45
	Turgot						7 38 51
	Zanoni						7 38 50
St. Hubert	Le Monier			achro. $10\frac{1}{2}$ feet			7 38 41
Ditto	Chabert	7 34 56	7 35 32	refractor 18 feet			7 36 52,5
Mifflon	Rochefort	7 27 7,5	7 27 7,5	achro. 3 feet			7 37 28,5
	My Son	7 26 55,5	7 26 55,5	telescope 18 inches	55		7 37 54,5
	Self	7 9 38,5	7 26 24,5	achro. 6 feet	30	7 20 25,5	7 37 42,5
							7 37 11,5

The

The place at Kew, where you observed, being 1' 9" to the West of the observatory at Greenwich, is of course 10' 25" West of that at Paris.

The observations in the table, joined by a stroke of the pen, were made together in the same place. You will perceive, in comparing the observations of the internal contact, how little the five last agree with the others. I am wholly ignorant in what light, the able astronomers, who observed at St. Hubert, consider their observations.

Monsieur le Monnier, in communicating them to me, adds no remarks, no more than in the letters he has wrote to me since. I come therefore to those made at the house called *La Mission*, situated in the neighbourhood of *Allemagne*, a village near this town. This house is about 500 toises South-East of my observatory at Caen, and their difference of meridians about 200 toises. I preferred this situation, from whence I could see the sun almost in the horizon, to that of my observatory; the adjacent houses of which, I foresaw, would deprive me of the sight of it, soon after the ingress of Venus.

June the first, I sent to the abovementioned house a six feet achromatic refractor, with its micrometer made by Dollond, magnifying 30 times: an excellent telescope of 18 inches focus magnifying from 55 to 200 times made by Short, and a clock.

June 2d, I took twenty altitudes of the sun, in the morning, to determine the going of a good compound pendulum, made by Le Paute, at Paris, which was to remain in the observatory at Caen, and to give the true times of the observations of the next day; and from corresponding ones in the afternoon, I

concluded by a mean, which agreed with the rest to less than one second, that it was slow on mean time at noon $2' 21'',8$; and that since the 25th of May, it had lost at the rate of $3''$ a day on the mean motion of the sun.

I then went to the *Misson*, to prepare for the operations of the next day; it had been more or less rainy from sun rising; but about six in the evening, the clouds dispersed and the sun set in the most auspicious manner.

June 3d, I took the following corresponding altitudes of the sun's superior limb; light clouds being troublesome.

A. M.			Alt.	P. M.			Noon by clock.		
h	'	"		h	'	"	h	'	"
8	43	20,0	44.00	15	7	25,0	11	55	22,5
	46	35,0	44.30		4	12,0		55	23,5
	48	12,0	44.45		2	33,0		55	22,5
	49	45,0	45.00		1	00,0		55	22,5
	51	24,0	45.15	14	59	23,0		55	23,5
	53	3,0	45.30		57	42,0		55	22,5
	57	55,0	46.15		52	49,0		55	22,0
	59	33,0	46.30		51	12,0		55	22,5
9	1	13,0	46.45		49	32,0		55	22,5
Mean Correction							11	55	22,5+
								—	4,3
Clock at true noon							11	55	18,2
Mean time at ditto							11	57	43,7
Clock slow on mean time								2	25,5

These corresponding altitudes being taken, I went, as the day before, about four o'clock to *La Misson*; where I met Monsieur de Rochfort, a gentleman of Caen,

Caen, and my son. It rained by intervals, as it had done the whole day ; the quicksilver in the barometer at noon being at 29,9 English inches, and Fahrenheit's thermometer in the observatory at 62°, the wind varying from the West to the North.

I compared the going of the clock I had with me, with that which remained in the observatory by signals repeated five times, and which agreed perfectly together : the same was done after sun set.

At half an hour past five, the clouds dispersed entirely : the sun shewed itself in all its splendor, and continued so the remaining part of the day.

About seven we all placed ourselves at our instruments ; Monsieur de Rochfort made use of a three feet achromatic refractor : my son of the 18 inch refractor : and I of the six feet achromatic refractor made by Dollond, and at 7^h 4' 58'',5 of the clock, or 7^h 9' 38'',5 apparent time, I perceived the external contacts of the Sun's and Venus's limbs.

As the impression on the Sun's limb seemed considerable when I perceived it, I concluded this observation too late, which I judged to be occasioned by a motion of undulation, with which the sun was strongly affected ; for this reason, in two letters wrote to Paris the 11th of June and the 14th of July, and communicated to the Academy of Sciences there, I do not hesitate to declare this observation insufficient ; it agrees nevertheless very well with yours made at Kew, and is nearly a mean between those of Greenwich, as may be seen by the table. However, I prepared myself with all possible care, for the observation of the internal contacts ; and though the Sun's limb moved continually up and down with a quick motion,

motion, I judged the internal contacts at $7^h 21' 44,5''$ by the clock, or $7^h 26' 24,5''$ apparent time, and $3''$ or $4''$ later, I saw a thread of light separate the planet from the Sun,

	h ' ''	} ap. time
Internal contacts, by M. de Rochfort	7 27 7,5	
By my son	7 26 55,5	

I find, by my register, that Monsieur de Rochfort judged his observation some seconds too late.

I perceived that Venus, before she separated from the Sun, was considerably stretched out towards his limb, which gave the planet nearly the form of a pear; and even after the separation of the limbs, Venus was twelve or more seconds before she resumed her rotundity.

	Clock			Ap. time			
	h	'	''	h	'	''	
At	7	30	27,0	7	35	7,0	Venus quite round.
	7	38	25,0	7	43	5,0	Venus's limb indented.
	7	45	8,c	7	49	48,0	Venus of a very irregular form, and strongly affected by an odd twisting motion.

I endeavoured to take the difference of right ascension of the Sun and Venus; but I would not make the former describe the æquatorial wire of the micrometer.

I cannot but repent having quitted my observatory, for the house in which I was; it is true indeed, as I have said, that I had the advantage of seeing Venus till sun set; but, in giving the preference to this situation, I unfortunately did not take notice, that
I had

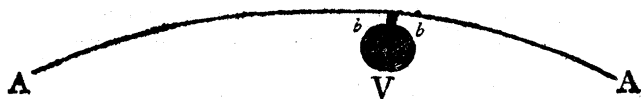
I had a river and a meadow between the Sun and me; the exhalations which rise from such places, especially towards the evening, produced, no doubt, that undulatory motion of the Sun, which must render observations made in such circumstances more or less dubious.

In short, I shall make two remarks on our observations: the first, that it seems odd, that the observation of the external contacts, which, for the reasons beforementioned, I judged had been made too late, agrees nevertheless both with yours and those of Greenwich: secondly, that although the internal contacts be marked by us sooner than by any other observers, except those of St. Hubert; we kept, nevertheless, the most scrupulous silence, nor did any motion indicate to the others, the times each wrote down; moreover, we were all three convinced that Venus and the Sun were separated, when we began to count the clock. However, I can but consider it as a misfortune, to have left my observatory, where the Sun's limb appeared perfectly well determined, even after the internal contacts, and not in the least affected by any motion or undulation, which were so troublesome to us; luckily I left a person in it, who did not neglect these favourable circumstances; and the observations there made are the more interesting, as the weather did not permit the external contacts to be observed, in any place from Caen to Brest, no more than at Paris nor in its environs.

Observations of the contacts of the Sun and Venus, made in my observatory at Caen, with a 17 inch refractor with $2\frac{3}{4}$ inches aperture.

Clock			App. time			
h	'	"	h	'	"	
7	4	40,0	7	9	20,0	Sun well determined : a very small impression appeared on its superior limb : it seemed even doubtful whether the contacts were formed.
7	4	52,0	7	9	32,0	The contacts very certain : this observation excellent, and it is thought the contacts could not have been seen sooner than $7^h 9' 20''$.
7	20	33,0	7	25	13,0	The following limb of Venus seemed to touch that of the Sun : the planet appeared quite round ; but soon after seemed to stretch itself out, and to form the tail, mentioned underneath : this observation is thought less certain than the others.
7	23	3,0	7	27	43,0	Internal contacts : by internal contacts must be understood the instant, when a sort of tail, such as is represented in the figure, and which joined Venus to the Sun's limb, separated from it so suddenly, that it is impossible there could have been an error of one second. There appeared instantly a considerable distance between the limbs ; that distance was not measured, but it might be $\frac{1}{2000}$ of the Sun's diameter ; and that distance was concluded from the comparison of the apparent length of this tail, to the diameter of Venus.

A A



A A represents the Sun's superior limb.

V Venus entirely upon the Sun only joined to his limb by the tail *bb*, which decreased in breadth till the instant of separation: the length of this tail seemed equal to $\frac{1}{6}$ of Venus's diameter.

The calculation of this tranfit of Venus over the Sun, was made from tables corrected by that of the 6th June 1761; and, compared to observation, give the following differences.

	Calculation			Observation			Difference		
	h	'	"	h	'	"			
External contacts	7	3	33.0	7	9	20.0	+	5	47
Internal contacts	7	22	27.0	7	27	43.0	+	5	16
Interval of contacts	0	18	54.0	0	18	23.0	-	0	31

June 4th light clouds flying and Fahrenheit's Thermometer at 60° I took the following equal altitudes of ☉ superior limb.

A. M.			Alt.	P. M.	Noon by clock
h	'	"	°		
9	44	6.0	53 00		
	45	58.0	53 15		
	47	49.0	53 30		
	49	40.0	53 45	Cloudy	
	51	36.0	54 00		
	53	29.0	54 15		
June 5 th cloudy					

June 6th, I took the following altitudes of Sun's superior limb.

A. M.			Alt.	P. M.	Noon by clock
h	'	"	°		
8	53	27,0	45		
	58	18,5	46		
	59	57,5	46		
9	1	38,5	47		
	4	53,5	47		
	8	14,5	48		
	11	37,5	48		
	13	16,5	48		
	14	58,5	49		
	16	40,5	49		
	18	23,0	49		

Cloudy

June 7th, cloudy.

June 8th, ditto.

June 9th, Fahrenheit's thermometer at 63°; I took the following corresponding altitudes of the Sun's superior limb. Weather hazy.

A. M.			Alt.	P. M.			Noon by clock			
h	'	"	°	h	'	"	h	'	"	
9	10	38,5	48	30	14	48	41,0	11	56	9,75
	17	23,5	49	30		34	57,0		56	10,75
	19	5,0	49	45		33	16,0		56	10,5
	20	46,0	50	00		31	35,0		56	10,5
	58	46,0	55	15		53	32,0		56	9,0
Mean							11	56	10,1	
Correction								—	2,7	
Clock at true noon							11	56	7,4	
Mean time at true noon							11	58	47,6	
Clock slow on mean time								2	40,2	
Ditto, June 3d								2	25,5	
Lost on mean time in 6 days								14,7		
Hence lost on ditto, per day									2,45	

It was from the corresponding altitudes of the Sun, taken the 3d and 9th of June, that I got the apparent times of the observations made at Caen ; these times may be easily verified, by the altitudes taken in the mornings of the 4th and 6th ; but I can sufficiently depend on the clock to dispense with that trouble.

I return you, dear Sir, many thanks for your observations of the transit, which you was so kind to send me ; it is the most circumstantial and compleat of any I have seen. What seems odd to me is, that neither M. le Monnier, as appears by his letters to me on this occasion, nor any of the observers at Paris, saw Venus stretched out as I did, nor any kind of tail : by your description of this tail, there must have been some little difference in its appearance, to that seen by the person in my observatory here.

If you think it will be acceptable to the Royal Society, I will take an opportunity of forwarding some other observations ; and among the rest, an account of a very remarkable degree of cold, and its effects on different liquids in the beginning of the year 1768, to which I attended with great attention. In the mean time, I am,

DEAR SIR,

Your most obedient

humble servant,

Nath. Pigott.